The Genetics of Parenthood—FACE LAB

Introduction to the Teacher

This is a simulation that easily captures student interest, and can be varied to meet different ability levels. Making the assumption that the P (parental) generation is heterozygous at all loci and that independent assortment occurs (no linkages), students flip coins to determine which allele they will pass on to the F1 generation, and draw the resulting child's face. Emphasize the variation that occurs, reminding the students that all of these children are genetic siblings since all parents have identical genotypes.

Several inheritance patterns are represented in this simulation, and it is important to review these with the students beforehand. *Inheritance of the traits used in this simulation has been simplified to serve as a model*. Actual inheritance is far more complex; students may need to be reminded about this in case they get overly concerned about their own traits.

- **Dominant**: allele which masks the expression of another; represented by capital letters (R, V)
- **Recessive**: allele which is expressed only if both parents contribute it; represented by small letters (r, v)
- **Incomplete dominance**: phenotype of the heterozygote is an intermediate form; represented by capital letters and subscripts (C1, C2); an example is red color tints in the hair
- **Polygenic**: several genes contribute to the overall phenotype; an example is skin color
- **Sex-linked**: commonly applied to genes on the X chromosome, the more current term is X-linked; genes on the Y chromosome are **holandric** genes; no examples in this activity
- **Epistasis**: one gene masking the effects of another; an example is hair color to red color tints

After students have completed their individual data sheets, they need to collect class data for at least traits # 2 and trait # 8 in order to answer the analysis questions. This is a good time for class discussion of the probability of individuals sharing multiple traits.

Materials

- 2 coins (preferably different kinds to keep track of mother/father contribution)
- The Genetics of Parenthood Student Reference Sheets (attached)
- drawing paper or white boards
- pens/crayons (Crayola has a "My World Colors" set for various skin/eye colors)

Additional Activity Ideas

1. Have each "parent" draw the child's face. Then compare the "mother's" and the "father's" perception of characteristics.
2. Do the lab twice, comparing the genotypes and phenotypes of the resulting siblings.
3. "Marry" the children off, to produce an F2 generation (grandchildren).

STUDENT REFERENCE

The Genetics of Parenthood Guidebook

Introduction

Why do people, even closely related people, look slightly different from each other? The reason for these differences in physical characteristics (called **phenotype**) is the different combination of **genes** possessed by each individual.

To illustrate the tremendous variety possible when you begin to combine genes, you and a classmate will establish the genotypes for a potential offspring. Your baby will receive a random combination of genes that each of you, as genetic parents, will contribute. Each normal human being has 46 chromosomes (23 pairs; **diploid**) in each body cell. In forming the gametes (egg or sperm), one of each chromosome pair will be given, so these cells have only 23 single chromosomes (**haploid**). In this way, you contribute half of the genetic information (**genotype**) for the child; your partner will contribute the other half.

Because we don't know your real genotype, we'll assume that you and your partner are **heterozygous** for every facial trait. Which one of the two available alleles you contribute to your baby is random, like flipping a coin. In this lab, there are 36 gene pairs and 30 traits, but in reality there are thousands of different gene pairs, and so there are millions of possible gene combinations!

Procedure

Record all your work on each parent's data sheet.

• First, determine your baby's gender. Remember, this is determined entirely by the father. The mother always contributes an X chromosome to the child.

Heads = X chromosome, so the child is a GIRL

Tails = Y chromosome, so the child is a BOY

Fill in the results on your data sheet.

• Name the child.

• Determine the child's facial characteristics by having **each** parent flip a coin.

Heads = child will inherit the first allele (ie. B or N1) in a pair

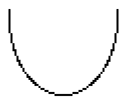
Tails = child will inherit the second allele (ie. b or N2) in a pair
On the data sheet, circle the allele that the parent will pass on to the child and write the child's genotype.

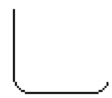
• Using the information in this guide, look up and record the child's phenotype and draw that section of the face where indicated on the data sheet.

• Some traits follow special conditions, which are explained below.

• When the data sheet is completed, draw your child's portrait as he/she would look as a teenager. You must include the traits as determined by the coin tossing. Write your child's full name on the portrait.

1. **FACE SHAPE**:
Round (AA, Aa) Square (aa)

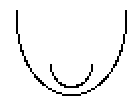


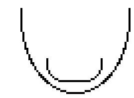


2. **CHIN SIZE**: The results may affect the next two traits.
Very prominent (BB, Bb) Less prominent (bb)

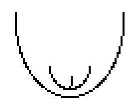
3. **CHIN SHAPE**: Only flip coins for this trait if chin size is very prominent. The genotype bb prevents the expression of this trait.

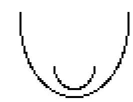
Round (CC, Cc) Square (cc)





4. **CLEFT CHIN**: Only flip coins for this trait if chin size is very prominent. The genotype bb prevents the expression of this trait.
Present (DD, Dd) Absent (dd)





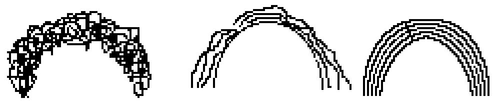
5. **SKIN COLOR**: To determine the color of skin or any other trait controlled by more than 1 gene, you will need to flip the coin for each gene pair. Dominant alleles represent color; recessive alleles represent little or no color. For example, if there are 3 gene pairs...

a. First coin toss determines whether the child inherits E or e.
b. Second coin toss decides F or f inheritance.
c. Third coin toss determines inheritance of G or g.
6 dominant alleles - black 2 dominant - light brown
5 dominant alleles - very dark brown 1 dominant - light tan
4 dominant alleles - dark brown 0 dominant - white
3 dominant alleles - medium brown

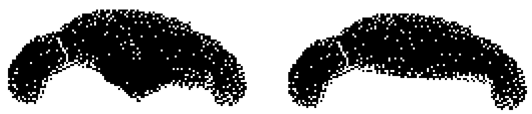
6. **HAIR COLOR**: Determined by 4 gene pairs.
8 dominant - black 3 dominant - brown mixed w/blonde
7 dominant - very dark brown 2 dominant - blond
6 dominant - dark brown 1 dominant - very light blond
5 dominant - brown 0 dominant - silvery white
4 dominant - light brown

7. **RED COLOR TINTS IN THE HAIR**: This trait is only visible if the hair color is light brown or lighter (4 or less dominant alleles for hair color).
Dark red tint (L1L1) Light red tint (L1L2) No red tint (L2L2

8. **HAIR TYPE**:
Curly (M1M1) Wavy (M1M2) Straight (M2M2)

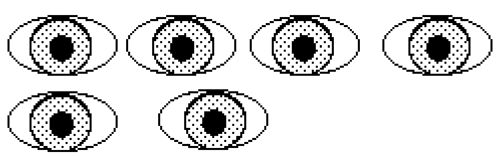


9. **WIDOW'S PEAK**:
Present (OO, Oo) Absent (oo)

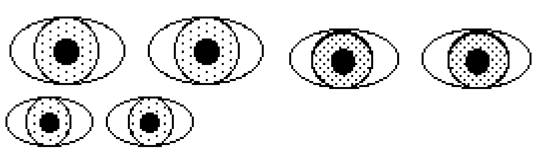


10. **EYE COLOR**:
PPQQ - black PpQq - brown ppQQ - green
PPQq - dark brown PPqq- violet ppQq - dark blue
PpQQ - brown with green tints Ppqq - gray blue ppqq - light blue

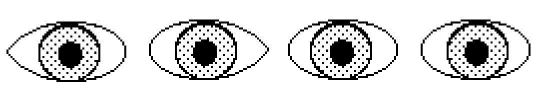
11. **EYE DISTANCE**:
Close (R1R1) Average (R1R2) Far apart (R2R2)



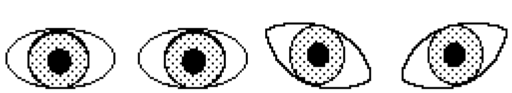
12. **EYE SIZE**:
Large (S1S1) Medium (S1S2) Small (S2S2)



13. **EYE SHAPE**:
Almond (TT, Tt) Round (tt)

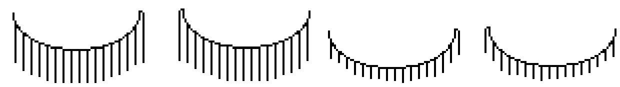


14. **EYE SLANTEDNESS**:
Horizontal (UU, Uu) Upward slant (uu)



15. **EYELASHES**:

Long (VV, Vv) Short (vv)



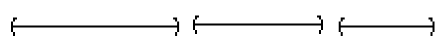
16. **EYEBROW COLOR**:
Darker than hair Same as hair Lighter than hair
color (W1W1) color (W1W2) color (W2W2)

17. **EYEBROW THICKNESS**:
Bushy (ZZ, Zz) Fine (zz)

18. **EYEBROW LENGTH**:

Not connected (AA, Aa) Connected (aa)

19. **MOUTH SIZE**:
Long (B1B1) Medium (B1B2) Short (B2B2)



20. **LIP THICKNESS**:
Thick (CC, Cc) Thin (cc)

21. **DIMPLES**:
Present (DD, Dd) Absent (dd)

22. **NOSE SIZE**:

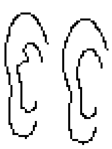
Large (E1E1) Medium (E1E2) Small (E2E2)

23. **NOSE SHAPE**:
Rounded (FF, Ff) Pointed (ff)

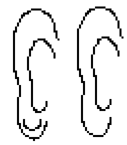
24. **NOSTRIL SHAPE**:
Rounded (GG, Gg) Pointed (gg)

25. **EARLOBE ATTACHMENT**:
Free (HH, Hh) Attached (hh)

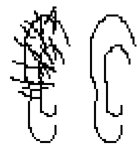
26. **DARWIN'S EARPOINT**:
Present (II, Ii) Absent (ii)



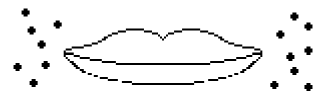
27. **EAR PITS**:
Present (JJ, Jj) Absent (jj)



28. **HAIRY EARS**: Males Only
Present (KK, Kk) Absent (kk)



29. **FRECKLES ON CHEEKS**:
Present (LL, Ll) Absent (ll)



30. **FRECKLES ON FOREHEAD**:
Present (MM, Mm) Absent (mm)

STUDENT WORKSHEET

The Genetics of Parenthood Data Sheet

Parents _______________________and ____________________________

Child's gender _____ Child's name________________________________

Fill in the data table as you determine each trait described in the Guidebook. Do not simply flip the coin for all traits before reading the guide, because some of the traits have special instructions. In the last column, combine the information and draw what that section of the child's face would look like.

#	TRAIT	ALLELE FROM MOM	ALLELE FROM DAD	CHILD'S GENOTYPE	CHILD'S PHENOTYPE (written)	CHILD'S PHENOTYPE (drawn)
1	Face Shape	**A a**	A a			face & chin
2	Chin Size	**B b**	B b			
3	Chin	**C c**	C c			

	Shape					
4	Cleft Chin	**D d**	D d			
5	Skin Color	**E e F f G g**	E e F f G g			
6	Hair Color	**H h I i J j K k**	H h I i J j K k			
7	Red Tints	**L1 L2**	L1 L2			hair
8	Hair Type	**M1 M2**	M1 M2			
9	Widow's Peak	**O o**	O o			
10	Eye Color	**P p Q q**	P p Q q			eye & eyelashes
11	Eye Distance	**R1 R2**	R1 R2			
12	Eye Size	**S1 S2**	S1 S2			
13	Eye Shape	**T t**	T t			
14	Eye Slant-edness	**U u**	U u			
15	Eyelashes	**V v**	**V v**			
16	Eyebrow Color	**W1 W2**	**W1 W2**			eyebrow
17	Eyebrow Thickness	**Z z**	**Z z**			
18	Eyebrow Length	**A a**	**A a**			
19	Mouth Size	**B1 B2**	**B1 B2**			mouth
20	Lip Thickness	**C c**	**C c**			
21	Dimples	**D d**	**D d**			
22	Nose Size	**E1 E2**	**E1 E2**			nose
23	Nose Shape	**F f**	**F f**			
24	Nostril Shape	**G g**	**G g**			
25	Earlobe Attach-ment	**H h**	**H h**			ear
26	Darwin's Earpoint	**I i**	**I i**			

27	Ear Pits	**J j**	**J j**			
28	Hairy Ears	**K k**	**K k**			
29	Cheek Freckles	**L l**	**L l**			
30	Forehead Freckles	**M m**	**M m**			

Questions for Analysis

1. What percentage does each parent contribute to a child's genotype?
2. Explain how/what part of your procedures represents the process of meiosis.
3. Using examples from this activity, explain your understanding of the following inheritance patterns:

d. dominant

e. recessive

f. incomplete dominance

g. polygenic

h. epistasis

9. Compare the predicted phenotype ratio (Punnett squares) to the actual ratio (class data) for the following traits:

j. trait # 2 (chin size)

k. trait #8 (hair type)

12. All the children had 2 heterozygous parents. Use the law of independent assortment to explain why there were no identical twins produced.